Deterministic coupling of photonic crystal nanocavity modes to single quantum dot excitons

K. Hennessy, A. Badolato, P. M. Petroff, E. L. Hu
Departments of Electrical & Computer Engineering and Materials, University of California, Santa Barbara, CA 93106

M. Atatüre, J. Dreiser A. Imamoğlu
Institute of Quantum Electronics, ETH Hönggerberg HPT G12, CH-8093 Zurich, Switzerland

We demonstrate a deterministic approach to realize devices for cavity quantum electrodynamics based on precise spatial and spectral coupling between a single InAs quantum dot (QD) and a GaAs photonic crystal (PC) nanocavity.

We position the QD in an ultra-small mode volume PC nanocavity, $V < (\lambda/n)^3$, by stacking tracer QDs above the viable QD up to the surface. We then fabricate a nanocavity around the tracer dot, thus locating the QD in the center of the PC membrane. By using a digital etching process, we controllably tune the nanocavity mode in small steps until we have spectrally engaged the QD.

By fine-tuning the high-*Q* cavity modes into resonance with any given exciton state of the QD, we observe high Purcell factors and non-trivial QD multi-exciton dynamics in **all** fabricated structures.